ENVIRONMENT & ENERGY
REPORTER

A periodical from Southern Research Institute about environmental challenges and technologies in the electric power, advanced energy, transportation, & GHG areas.

Winter 2006

Greenhouse Gas Mitigation Establishes Role in the Energy Mainstream

> *"I've asked my advisors to consider approaches to reduce greenhouse gas emissions, including those that tap the power of markets, help realize the promise of technology and ensure the widest-possible global participation . . ."*
>
> *President Bush*
> *June 11, 2001*

Greenhouse gas (GHG) emissions mitigation and energy efficiency technologies are closely entwined. The federal government has addressed energy security, in part, through efficiency measures and greenhouse gas reductions through voluntary programs such as Climate Leaders, Climate VISION and CHP Partnerships. The Energy Star, Natural Gas Star, Methane-to-Markets, SmartWay Transportation and Southern Research's own GHG Center (see sidebar) all drive simultaneously toward emission reduction and improved energy recovery and efficiency. The Bush Administration re-emphasized its GHG commitments in the September release of the draft U.S. Climate Change Technology Program Strategic Plan.

See GHG Mitigation, page 4

GHG Center Verifies 30-Plus Technologies

The Greenhouse Gas Technology Verification Center (GHG Center) is a public/private partnership between the U.S. EPA and Southern Research Institute, operating under the EPA's ETV program. The GHG Center (www.sri-rtp.com) seeks promising greenhouse gas mitigation technologies, subjects them to independent performance testing, and provides performance results to the public free of charge. To date, the GHG Center has verified - or is in the process of verifying - more than 30 different environmental and energy technologies that can significantly impact GHG emissions.

Environmental Technologies Verified by the GHG Center

Technology Class	Vendor and Technology Name	Technology Performance Features
Oil and gas production and transmission	A&A Environmental Seals, Seal Assist System (two phase verification)	Gas compressor rod leak mitigation
	France Compressor Products, Emissions Packing	Idle compressor rod gas leak mitigation
	C. Lee Cook, Static Pac System (two phase verification)	
	Protectoseal Company, Pin-Tech Relief Vent	Gas leak mitigation
	COMM Engineering, EVRU	Vent gas recovery system
	Engineered Concepts, Quantum Leap Dehydrator	Low emission glycol gas dehydration
	Miratech Corp., GECO Air/Fuel Ratio Controller (two phase verification)	Lean burn engine air/fuel ratio controller for improved efficiency and reduced emissions
Advanced heat and power production	International Fuel Cell PC25	200 kW fuel cell power from landfill gas
	Honeywell, Parallon 75 kW Turbogenerator	gas-fired microturbine power generation
	Honeywell, Parallon 75 kW Turbogenerator with Low CO	75 kW gas-fired microturbine power with CO emissions catalyst
	Mariah Energy Corp., Heat PlusPower System	Gas-fired microturbine with CHP
	Ingersoll-Rand, IR PowerWorks 70 kW	
	Capstone, 60 kW Microturbine at supermarket	
	Aisin Seiki, G60 Cogeneration Unit	6 kW engine based CHP
	Plug Power, SU1 Fuel Cell	5 kW residential PEM fuel cell power
	ECR Technologies, Earthlinked Ground Source Heat Pump	Geothermal hot water heater
Waste to Energy	Capstone, 30 kW Microturbine at farm	Biogas-fired microturbine with CHP
	DDI FARME, 70 kW Microturbine at farm	
	Martin Machinery IC Engine	Biogas-fired engine CHP
	UTC Fuel Cells, PC25 Power Plant	Biogas fueled PAFC with CHP
	Nateo Group, Thiopaq Gas Purification Technology	Biogas and sour gas cleanup
	US Filter Westates, Biogas Treatment System	
Transportation	Conoco Philips, 75W90 Lubricant	Axle lubricant
	NCI, The Condensator	Diesel engine crankcase ventilation retrofit
	Envirofuels, Diesel Fuel Catalyzer	Diesel fuel additive
	White Sands, Cleanboost Diesel Fuel Additive	
Other Industrial	ANR Pipeline, Parametric Emission Monitoring System	Emissions monitoring for gas-fired engines
	KMC Controls, SLE-1001 Sight Glass Monitor	Refrigerant leak detection
	JCH Fuels, Enviro Automated Fuel Cleaning System	Diesel fuel cleanup

The GHG Center is verifying or soliciting verifications of commercial ready technologies in the following areas: advanced energy production, waste-to-energy conversion, oil and gas production and transmission, transportation technologies, and other energy efficiency technologies.

The GHG Center is planning for performance assessments of clean electricity generation technologies including biomass and biogas fuels, hydrogen production and use technologies, improved fuel cell and microturbine systems, industrial cogeneration and combustion systems, and alternative transportation fuels and technologies.

Peaking Projections Suggest Worldwide Oil Shortages Ahead

Swift Action Needed to Avoid Transportation Fuel Disruptions

The world consumed about 80 million barrels of oil per day in 2003, with two-thirds used to make transportation fuels. Even at such a large level of consumption, global demand may double or triple over the next 20 to 50 years as countries such as China and India, with their rapidly growing economies, accelerate energy use.

Can the world meet such an enormous demand? Although projections and theories vary on when and if the world's oil production will peak and begin to decline, many analysts suggest the peak is not far away. In a recent study funded by the U.S. Department of Energy, world oil peaking was projected to occur by 2020 and decline rapidly from there (R.L. Hirsch, 2005).

In another analysis by the Energy Information Administration, less dramatic peaking scenarios were projected though still relatively near term. That analysis concludes that world peak crude oil production could occur between 2021 and 2112, with an expected or mean date of 2037. The report recognizes that many credible analysts are more pessimistic, and that the most optimistic forecasts suggest peaking in less than 25 years.

Most analysts suggest that urgent actions are needed on the supply and demand sides

Gas lines during the 1970's oil shock

See Oil Shortages, page 3

Mitigating Potential "blue plumes" - Solutions Underway

The last issue of E&E Reporter discussed how SO_3, generated in SCR units on coal-fired power plants, produces H_2SO_4 emissions. In that issue, 850 individual boiler units were cited as possibly experiencing adverse plume visibility from Clean Air Interstate Rule-forced control device installations. More recent analyses suggest the phenomena may impact fewer units because units larger than about 250 MW will be the only ones impacted by the rule, and of these units only about 250 might experience "blue plume" problems.

Furthermore, only about 10 percent of the latter might require mitigation to alleviate potentially high ground-level H_2SO_4 concentrations. Though the breadth could be less, research to mitigate "blue plumes" is advancing, and commercial and near-commercial technologies are emerging.

Individual electric utility companies, the U.S. DOE, the U.S. EPA, vendors, and the Electric Power Research Institute are all actively engaged in efforts to better understand and address the "blue plume" issue. Several approaches that could mitigate the problem are under investigation by utilities and others and most involve injection of various reagents upstream of the pollution control equipment. The reagents of interest include magnesium oxide, lime, ammonia, and sodium bisulfite. Wet electrostatic precipitators also offer H_2SO_4 control potential when installed downstream of wet scrubbers. The latter also provides an added benefit of further particulate and HAP control.

Joe McCain - veteran Southern Research engineer and physicist

Joe McCain, a 36-year veteran in Southern Research's utility programs, has spent the past few years addressing "blue plumes" in the field and in Southern Research's combustion and other research labs. "In retrofit applications, sodium bisulfite, trona, magnesium oxide, and lime are the chemicals of choice to mitigate SO_3 and H_2SO_4 impacts" said McCain. "We know of the routine use of sodium bisulfite on at least 13 units operated by different utilities. Magnesium oxide has been in routine use on oil-fired utility boilers for many years, and trona and lime are in use or in field trial by utilities like TVA and AEP." Trona and lime vendors are actively optimizing the performance of their products.

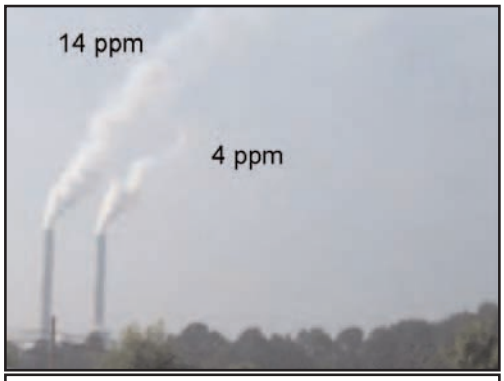


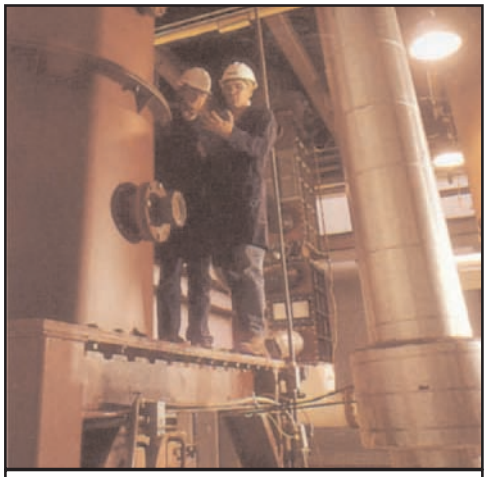
Photo shows plumes from twin units, each with an ESP followed by a wet scrubber. H_2SO_4 on right hand unit (4 ppm) is controlled by lime injection and the other (14 ppm) is not.

McCain continued that "It's probably too early to say for sure, but permit applications for new power plant construction indicate wet electrostatic precipitators may be favored for the control of SO_3 and H_2SO_4 emissions. For example, both We Energies and Louisville Gas and Electric are specifying a combination of SCR, fabric filter, wet scrubber, and wet ESP for control of nitrogen oxides, particulates, SO_2, and SO_3 and H_2SO_4 aerosols. It is likely that this combination of technologies will also provide some mercury control simultaneously, and if not enough, activated carbon injection is available."

H_2SO_4 and "Blue Plume" Studies at Southern Research

Under the sponsorship of the U.S. DOE, Southern Research recently completed development of a semi-continuous SO_3/H_2SO_4 emissions monitor. In the course of that work a sampling probe was developed that shows promise for improving SO_3/H_2SO_4 emission measurements. Southern Research is also working with control equipment vendors and utilities to provide accurate measurements of plant emissions and both full-scale and pilot-plant assessments of control system performance across a range of mitigation technology types.

Southern Research, under the sponsorship of the U.S. EPA, is in the process of developing predictive models for SO_3/H_2SO_4 emissions from coal-fired boilers. These models are to include both formation of SO_3 in the boiler and across SCRs, uptake by ash (a major removal mechanism), removal by air preheaters, and removal by various emission control systems such as electrostatic precipitators, fabric filters, and various types of wet and dry scrubbers. In a laboratory program for the U.S. EPA, Southern Research is obtaining data on the uptake of SO_3 and H_2SO_4 by flyash formed by a wide range of coal types and coal mineral compositions.



Trials of several standard and developmental reagents have occurred at the Combustion Research Facility located at Southern Research's Birmingham headquarters.

Oil Shortages

Continued from page 1

to divert major oil shortages this century and to blunt subsequent economic upheaval and social crises. There are different ways to mitigate the shortages, but most will require decades of sustained effort, and given peaking may only be a few decades away, immediate action seems justified. For example, alternative oil production processes, like coal liquefaction and heavy oil/oil sands recovery, are commercial but could require 20 years to become a significant part of the world's mainstream fuel supply. Demand side strategies, like stringent CAFE standards for motor vehicles could be implemented quickly but won't significantly penetrate existing fleets for 7-10 years.

Hirsch estimates that waiting until world oil production peaks before starting a crash program would leave the world with a significant liquid fuel deficit for over two decades. Initiating a crash program 10 years before peaking helps, but still leaves a liquid fuels shortfall a decade after the time that oil would have peaked. Initiating crash programs 20 years before peaking may avoid a world liquid fuels shortfall altogether.

The next issue of the E&E Reporter will focus on a more in-depth assessment of oil-based transportation fuel alternatives.

Mitigation Option	Preparation Delay (years)	Impact 10 Years Later (MM bpd)
Vehicle Efficiency	3	2
Gas-to-Liquids	3	2
Heavy Oil / Oil Sands	3	8
Coal Liquids	4	5
Enhanced Oil Recovery	5	3

About *The Environment & Energy Reporter*

The Environment & Energy Reporter is published quarterly by the Environment and Energy Department at Southern Research Institute, an independent contract research organization based in Alabama, North Carolina, and Florida. For more information about the projects and capabilities in this newsletter, please contact us by email at info@sri-rtp.com or call 919-806-3456.

Hot-Gas Cleanup for IGCC is a Key to Technology Success

The Power Systems Development Facility

Coal supplies are abundant and account for more than half of the electric power generation in the U.S., and will likely continue to be a major source of power well into the 21st century. The sustained, long-term use of coal will require advanced coal-based power systems that are more efficient and more environmentally acceptable than current plants. Integrated gasification combined cycle (IGCC) is one advanced power system that is particularly attractive.

According to a recently published EPA study, an IGCC process offers significant environmental advantages over a conventional pulverized coal-fired plant, including lower air emissions for all major pollutants, reduced solid waste generation, less cooling water usage, and lower unit derating for CO_2 removal and sequestration.

To maximize the potential of coal-based IGCC systems, syngas generated in the coal gasifier must be cleaned before the gas is used in a combustion turbine or elsewhere. The most promising technology for accomplishing this is high-temperature emissions removal using ceramic or sintered metal hot-gas filter elements.

Southern Research is helping advance hot-gas filter technology through work at the Power Systems Development Facility (PSDF). The facility is operated by Southern Company Services (SCS) for the U.S. Department of Energy with funding provided by DOE, SCS, and other industrial participants. In October 2004, DOE announced that Southern Company, along with the Orlando Utilities Commission and Kellogg, Brown and Root, were selected to build an advanced 285-Megawatt coal gasification facility at Stanton Energy Center in Orlando, Florida.

A cluster of sintered metal filter elements is covered with char from a coal gasification test campaign. One focus of Southern Research's work at the PSDF is to understand the factors affecting the buildup and flow resistance of char dustcakes.

Based on work at the PSDF, filter operations have reached a point where broken filters are rare and outlet particle loadings below 0.1 ppmw are routinely achieved. Vast improvements have also been made in failsafe technology, which controls emissions when filters fail. One remaining issue is improving the understanding of factors that affect dustcake flow resistance or drag-critical to the development of reliable procedures for sizing new hot-gas filter systems. Southern Research has custom-built a system for measuring drag under conditions that simulate the collection of the gasification ash in the hot-gas filter, providing design information on how dustcake drag is affected by changes in coal type, operating conditions, particle size, and carbon conversion.

Representative characterizations of gasification ash are critical to understanding filter performance and diagnosing filter problems. Using a one-of-a-kind sampling system developed by Southern Research, in-situ ash data from the PSDF have been collected with nearly 100 percent availability for over 10 years, providing samples that accurately represent the material being collected in the hot-gas filter. Since samples are collected at process conditions, they are not subject to particle loss, particle-size alteration, and condensation, which are problems that commonly occur with extractive sampling systems.

GHG Mitigation *Continued from page 1*

Thirty-five states and Puerto Rico have developed greenhouse gas inventories. More than 28 states and Puerto Rico have completed action plans, and more than 140 U.S. cities and towns have joined the Cities for Climate Protection (CCP) campaign.

While these and other actions are underway, many in industry and government understand that as a practical matter, coal is a plentiful and indigenous fuel with a capacity to support the projected demand for energy, especially electric power, for the next century and beyond. These factors have spurred the development and demonstration of "clean coal" technologies such as Integrated Gasification Combined Cycle (IGCC), oxy-firing (see sidebar on Oxy-Firing Research), CO_2 sequestration, and other technologies by U.S. power producers, trade organizations, government agencies and others. Most of these technologies, though promising, are developing.

Whether by voluntary efforts in government and businesses, new regulatory requirements, or stockholder, market, public or political pressures, the number of organizations seeking GHG reductions in the U.S. is growing. Technologies that currently exist, though not normally associated with GHG mitigation, help to reduce GHG.

Southern Research, through the Environmental Protection Agency's Environmental Technology Verification (ETV) program, has confirmed the operational and GHG emissions performance of more than 30 such technologies in the electric power, transportation, natural gas, and other sectors. (See page 1 on GHG Center technologies) Though some technologies did not perform as vendors had hoped during independent testing, many were found to be effective and profitable to operate.

Verifications generally involve the measurement of energy conversion efficiency, air pollution emission rates, secondary environmental impacts, operational performance, cost performance, and other variables of interest to purchasers and other stakeholders. Technology performance verifications are accomplished using measurement and analysis methods that have been reviewed and revised based on input from independent stakeholder panels.

"Once we've verified a technology's performance, not only does the company who developed it benefit, but it gives potential purchasers of the technology some assurance about its value," says Tim Hansen, director of the Greenhouse Gas Technology Verification Center at Southern Research.

Job Opportunities in Environment and Energy

Birmingham, AL

Senior Project Engineer - Develop and direct applied air pollution control research projects in the power industry. The work could involve designing test equipment, developing test plans, and directing and managing testing and analysis programs at pilot-scale laboratories, full-scale power plants, and slipstream facilities at power plants.
Job Code: sr-01680

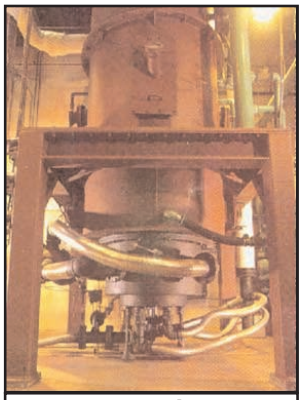
Project Engineer - Assist with applied air pollution control research projects in the power industry. This work will involve assisting with the activities listed above, and engaging in a growth plan to operate more independently.
Job Code: sr-01690

Birmingham, AL; Pensacola, FL; Research Triangle Park, NC

Principal Investigator - Mercury Research Center: Develop and lead demonstration, testing, and research projects of mercury control and other environmental control technologies at a new slip-stream demonstration facility located in Pensacola, Florida. Could be filled at any of three locations.
Job Code: sr-01645

Please Apply Online at: www.southernresearch.org
EOE/AA

Combustion Laboratory at Southern Research Preparing for Oxy-Fired CO_2 Recycle Technology



CRF Furnace and Low-NO_x Burner

Concerns over greenhouse gases and energy security are growing, and one course the nation is taking is to develop advanced coal-based energy systems. This includes technologies like gasification combined cycle for producing electricity efficiently, and combined electricity and hydrogen production for future use in the transportation and energy sectors. These advanced energy systems yield a concentrated effluent of CO_2 which may be sequestered or processed further.

In the electricity sector, it would be a challenge for the nation to jump directly from its existing large stock of coal-fired power plants to a new fleet of more advanced energy systems. A gradual replacement seems more likely, but never-the-less, pressure to lower CO_2 emissions continues building now. Given that, a technology capable of providing reductions in GHG emissions from existing plants may have a market in the near future.

Southern Research was recently awarded a project by the U.S. Department of Energy to conduct a three-year investigation of retrofit Oxy-Fired CO_2 Recycle technology for existing coal-fired power plants. The project will begin by retrofitting Southern's Combustion Research Facility (CRF) to allow for oxy-firing and recycle. By converting to oxygen firing, and recycling some flue gas, the flame temperatures and the system time/temperature flow profiles may be maintained - both essential for the use of existing equipment. The retrofit should result in a four-fold reduction in flue-gas volume, a concentrated CO_2 flue gas stream ready for sequestration or other use, and increased combustion efficiency.

Data that utilities can use to optimize the retrofit of this technology to full-scale power plants will be generated here and in the projects that will follow. Detailed response maps will be developed for heat transfer efficiency, pollutants, and carbon burnout as a function of operating parameters.